

1/f noise



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1 / f noise, or more accurately **1 / f^α noise**, is a signal or process with a power spectral density proportional to $1 / f^\alpha$,

$$S(f) = \frac{\text{constant}}{f^\alpha}$$

where f is the frequency. Typically use of the term focuses on noises with exponents in the range $0 < \alpha < 2$, that is, fluctuations whose structure falls in-between white ($\alpha = 0$) and brown ($\alpha = 2$) noise. Such "1 / f -like" noises are widespread in nature and a source of great interest to diverse scientific communities.

The "strict 1 / f " case of $\alpha = 1$ is also referred to as **pink noise**, although the precise definition of the latter term^[1] is not a 1 / f spectrum per se but that it contains equal energy per octave, which is only satisfied by a 1 / f spectrum. The name stems from the fact that it lies in the middle between white (1 / f^0) and red (1 / f^2 , more commonly known as Brown or Brownian) noise^[2].

The term **flicker noise** is sometimes used to refer to 1 / f noise, although this is more properly applied only to its occurrence in electronic devices due to a direct current. Mandelbrot and Van Ness proposed the name **fractional noise** (sometimes since called **fractal noise**) to emphasise that the exponent of the spectrum could take non-integer values and be closely related to fractional Brownian motion, but the term is very rarely used.

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Description

In the most general sense, noises with a 1 / f^α spectrum include white noise, where the

power spectrum is proportional to $1/f^0 = \text{constant}$, and Brownian noise, where it is proportional to $1/f^2$. The term black noise is sometimes used to refer to $1/f^\alpha$ noise with an exponent $\alpha > 2$.

Pink noise

[1]

Relationship to fractional Brownian motion

The power spectrum of a fractional Brownian motion of Hurst exponent H is proportional to: $1/f^{2H+1}$

See also

- Colors of noise
- Detrended fluctuation analysis
- Hurst exponent

References

Notes

1. ^a ^b Federal Standard 1037C and its successor, American National Standard T1.523-2001.
2. ^a Confusingly, the term "red noise" is sometimes used instead to refer to pink noise. In both cases the name springs from analogy to light with a $1/f^\alpha$ spectrum: as α increases, the light becomes darker and darker red.

Bibliography

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